

國立臺灣海洋大學九十九學年度研究所碩士班暨碩士在職專班入學考試試題

考試科目：冶金熱力學

系所名稱：材料工程研究所碩士班金屬材料組

\*可使用計算器

1. 答案以橫式由左至右書寫。2. 請依題號順序作答。

Some constants or known symbols:

- (1) Gas constant  $R = 8.314 \text{ J/mole-}^\circ\text{K} = 2 \text{ cal/mole-}^\circ\text{K} = 0.082 \text{ liter-atm/mole }^\circ\text{K}$
- (2)  $H, U, G, S, P, V$  and  $T$  represent the enthalpy, internal energy, Gibbs free energy, entropy, pressure, volume and temperature, respectively.
- (3)  $\log 2 = 0.3010, \log 3 = 0.4771$
- (4)  $\ln(x) = 2.303 \log(x)$ , where  $x > 0$
- (5)  $\exp(n) = e^n$ ,  $\exp(1) = 2.71828, \exp(2) = 7.38906, \exp(0.1) = 1.10517, \exp(0.2) = 1.22140, \exp(0.3) = 1.34986, \exp(0.4) = 1.49182, \exp(0.15) = 1.16183, \exp(0.25) = 1.28402, \exp(0.35) = 1.41907$

1. (total 12%)

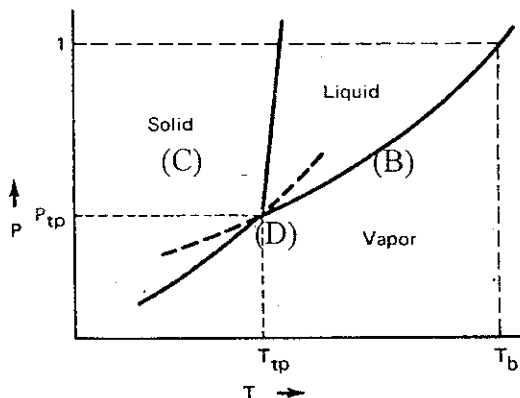
Why Gibbs free energy is widely used in thermodynamics ?

(Hint: state function, reaction equilibrium)

2. (total 16%)

(A) Derive the Gibbs phase rule.  $F = C + 2 - P$  (10%) (Hint: considering the variables and equations)

Explain freedom in the below phase diagram for (B) two phase coexisted line, (C) single phase stable region & (D) triple phase point. (6%)



3. (total 12%)

Why iceskating is possible? Derive the Clapeyron equation.

4. (total 14%)

Demonstrate the meanings of Raoult's Law and Henry's Law. (6%)

Why in a binary solution Henry's law is obeyed by the solute in that composition range over which Raoult's law is obeyed by the solvent? (8%) (Hint: Gibbs-Duhem equation)

5. (total 12%)

Describe the differences between an ideal and a regular A-B solution in terms of the thermodynamic properties. ( $\Delta G$ ,  $\Delta H$  and  $\Delta S$ )

6. (total 16%)

A rigid container is divided into two compartments of equal volume by a partition. One compartment contains 1 mole of ideal gas *A* at 1 atm, and the other contains 1 mole of ideal gas *B* at 1 atm. Calculate the increase in entropy which occurs when the partition between the two compartments is removed. If the first compartment had contained 2 moles of ideal gas *A*, what would have been the increase in entropy when the partition was removed? Calculate the corresponding increases in entropy in each of the above two situations if both compartments had contained ideal gas *A*.

7. (total 18%)

A gas mixture of 30% CO, 35% CO<sub>2</sub> and 35% H<sub>2</sub> by volume is fed into a furnace at 700°C.

(A) Calculate the  $\Delta G^\circ$  and  $K_p$  at 700°C. (8%)

(B) Find the composition of the equilibrium CO-CO<sub>2</sub>-H<sub>2</sub>O-H<sub>2</sub> gas if the total pressure in the furnace is 1 atm. (10%)

